The TELLURIDE project: simulating the foundry process

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Casting metal components, rather than forming, is important to industry because it enables mass production of geometrically complex components at potentially lower cost. However, casting has risks. Waste can be high because cast parts often do not meet specifications. Rejected parts may contain macrosegregation of alloying metals, an internal stress buildup which could lead to dimensional distortion, or inclusion of void. Defects are extremely difficult to eliminate once the part is cast. An analysis tool to accurately simulate the gravity pour, cooling, and solidification of molten metal could have a major impact on part fabrication. It could influence important design decisions, such as mold thickness, mold cooling, and mold venting. An interdivisional team at Los Alamos is developing such a comprehensive numerical tool called TELLURIDE.

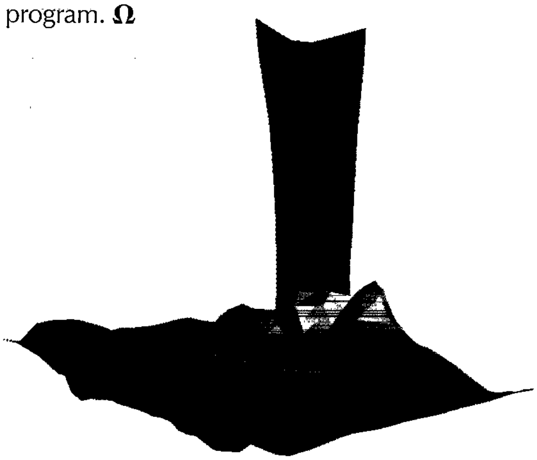
The principal goal of the TELLURIDE effort is the development of a three-dimensional, multifluid, low-speed flow model for simulation of the gravity pour processes conducted at Los Alamos. The model utilizes modern, high-resolution, finite-volume algorithms and physically-based models designed for generally unstructured meshes. The data parallel algorithms, implemented in FORTRAN 90, are designed for current and next generation high-performance computer architectures.

The team members and their responsibilities include Richard LeSar, MST, and John Cerutti, XHM, program management; Doug Kothe, T-3, technical direction, especially fluid flow and surface tension packages; Jay Mosso, XHM, advection and interface tracking; John Turner, XTM, linear algebra; Jerry Brock, T-3, particle-based models; Anand Reddy, T-3, alloy phase change modeling, Brian Lally, ESA-EPE, heat transfer; and Robert Ferrell, CPCA, parallel gather-scatter methods.

In TELLURIDE this group is producing a code that integrates all the relevant processes of fluid flow, heat transfer, solidification, and interface dynamics. The current simulation tools fail to meet these requirements, especially with regard to the unique alloys cast in our foundries. Jay says, "TELLURIDE is drawing from the algorithms and experience that we have built into MESA and PAGOSA—two highly successful simulation tools."

TELLURIDE must adapt easily to the complex geometries and flow obstacles present in casting applications. The conservation laws are solved on a fully unstructured grid in TELLURIDE rather than a logically rectangular mesh as in MESA and PAGOSA. Unstructured meshes are easily partitioned by automated domain decomposition tools into separate submeshes for individual processing elements in multiprocessor architectures. Meshes originating from any number of widely used mesh generation tools are accepted.

TELLURIDE could prove valuable in assessing the viability of near-netshape castings of weapon components. The accurate casting of parts should reduce or eliminate the amount of machining required to produce weapons components. The current machining operations generate a large amount of hazardous waste. The reduction of this waste stream is vital to the SBSS program. **Ω**



◄ *A TELLURIDE simulation of molten metal filling a box.*

▼ *Richard LeSar, Doug Kothe, and Jay Mosso examine the heat transfer within an ALCOA cast aluminum part.*